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# New records of *Amanita* from Tehuacán-Cuicatlán Biosphere Reserve, México

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Abstract—Specimens of *Amanita caesarea*, *A. flavoconia*, *A. flavorubescens*, *A. fulva*, *A. onusta*, *A. pantherina*, *A. rubescens*, *A. vaginata*, and *A. verna* are described as new records from Tehuacán-Cuicatlán Biosphere Reserve. There were no records of mycetism produced by the consumption of those species in the reserve.

Key words—*Amanitaceae*, *Agaricales*, edible, Oaxaca, taxonomy, toxic

## Introduction

Ruiz-Oronoz & Herrera (1948) and Herrera (1950) were to first to initiate mycological research in the Cuicatlán district of Oaxaca. In 1998, President Ernesto Zedillo Ponce de León proclaimed the studied region as the Natural Protected Area of Tehuacán-Cuicatlán Biosphere Reserve in the states of Puebla and Oaxaca, México, with the intent of conserving its plant, animal, and fungal diversity as well as its huge human cultural wealth. Since mycological studies were restarted in 1996, fungi have been collected in different the vegetation types of tropical subdeciduous forest, deciduous forest, and pine–oak forest. As a result of collaborative work amongst the Institute of Biology (National Autonomous University of Mexico), Ejidal and Communal Commission of Tehuacán-Cuicatlán, and National Commission of Natural Protected Areas with the communities of San Pedro Jocotipac and Santa María Pápalo, nine species of *Amanita* (*Agaricales, Amanitaceae*) have been recorded from this region for the first time.

The aim of this research was to extend the taxonomic knowledge of *Amanita* as an exploitable natural resource. Of the nine *Amanita* spp. identified, four were edible and five were toxic (one fatally poisonous). In view of the fact that the reserve's mycobiota is basically unknown, it is imperative that fungal research be continued in the region.

## Materials & methods

Specimens were collected in oak forests in the Cuicatlán district. Digital pictures, field data, and macro- and microscopical characterization of samples were performed. Collections are deposited in the Fungus Collection of the National Herbarium, Institute of Biology, National Autonomous University of México (MEXU). Colour codes in descriptions follow Kornerup & Wanscher (1978). Morphological structures were observed using a stereomicroscope and compound light microscope. Basidiomes were sectioned and mounted in ammonia water (1%), KOH (5%), Melzer reagent, neutral red (1%), and cotton blue in lactic acid solutions. Species were identified consulting Bas (1969), Jenkins (1977), Arora (1986), Pérez-Silva & Herrera (1991), Phillips (1991), and Tulloss et al. (1992).

## Taxonomy

***Amanita caesarea*** (Scop.) Pers., Syn. Meth. Fung. Pars 2: 252 (1801). Fig. 1

Basidiome 90–120 mm high. Pileus 5.5–10.5 mm diam., convex, becoming flatter in age, with long striate margin; disc high red to vivid red (11A8), paler toward the margin. Lamellae 8 mm broad, adnate, with entire edge, pale yellow (4A3). Stipe 9–12 × 8–17 cm, pale yellow, with darker orange fiber or patches; annulus pendulous, membranous, yellowish, attached to the upper stem, often striate; no basal bulb, white volval sac. Context white to yellowish. Odor & taste pleasant.

Basidiospores 8–16.5 × 5.5–8 µm, elliptical, thin-walled; basal cylindric apiculus; uniguttulate, broadly ellipsoid; hyaline, inamyloid. Basidia 38.5–49.5 × 10–11 µm, tetrasporic, with basal clamp connections.

Ecology—Solitary (rarely in groups) in pine–oak woods during July–November; mycorrhizal; widely distributed in México, where it is reported as an edible of excellent culinary value; commonly called "yellow fungus" (Pérez-Silva & Herrera 1991).

Specimens examined: **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina Ruíz, A. de la Cruz Martínez (MEXU 27820); El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27827).

Comments—*Amanita caesarea* is easily distinguished by its bright yellow gills and stipe, brilliant red to orange cap with striate margin, and voluminous white

Figures 1–8. *Amanita* species basidiomata. 1: *A. caesarea* (MEXU 27827). 2: *A. flavoconia* (MEXU 27828). 3: *A. fulva* (MEXU 27833). 4: *A. onusta* (MEXU 27823). 5: *A. pantherina* (MEXU 27835). 6: *A. rubescens* (MEXU 27832). 7: *A. vaginata* (MEXU 27824). 8: *A. verna* (MEXU 27825).

volva (Arora 1986). Fresh mushrooms are sold at markets and along roadsides in México (Montoya et al. 2001) and the United States (Volk 2017). *Amanita jacksonii* is similar, but differs by its larger, bright orange-red basidiome and occurrence in northern mixed forests of Canada.

***Amanita flavoconia*** G.F. Atk., J. Mycol. 8(3): 110 (1902). Fig. 2

Basidiome 80 mm high. Pileus 40–60 mm diam., convex, becoming broadly flatter when maturing, yellowish red (8B8); surface often viscid, with bright yellow universal veil remnants; not striate margin. Lamellae 7 mm broad, white to pale yellow (4A3), free from stem, with entire edge. Stipe 60–80 × 5–9 mm, white to yellowish, membranous annulus to the apex, pale yellow; swollen basal bulb, 20 mm diam., covered with yellow floccose veil fragments, friable volva. Context white. Odor & taste pleasant.

Basidiospores 8–9 × 6–7 µm, ovoid, hyaline, amyloid, thin-walled. Basidia 33–38 × 8–8.5 µm, clavate, tetrasporic. Pileipellis hyphae 2–5 µm wide, gelatinized filamentous; oleiferous hyphae 2–4 µm wide.

Ecology—Solitary in pine-oak woods; fructification during July–November; wide distribution in México (Pérez-Silva & Herrera 1991). Villanueva-Jiménez et al. (2006) cited from Ixtlán, Oaxaca.

Specimen examined: **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina-Ruíz, A. de la Cruz Martínez (MEXU 27821); El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27828).

Comments—*Amanita flavoconia* has been reported as toxic in several localities in USA (Metzler & Metzler 1992) and may cause gastrointestinal mycetism. Benedict et al. (1966) did not detect ibotenic acid or muscimol nor did Chilton & Ott (1976) find toxic metabolites. Aroche et al. (1984) reported presence of amanitins.

***Amanita flavorubescens*** G.F. Atk., J. Mycol. 8(3): 111 (1902).

Basidiome 60 mm high. Pileus 40–60 mm diam., convex, becoming flatter when maturing, orange yellow (4A8); thick yellow warts of volva around center. Lamellae 5 mm broad, white to pale yellow (4A3), free from stipe, white pulverulent edge. Stipe 50–70 × 3–7 mm, yellow to pale yellow, narrower at the apex, pruinose to powdery; annulus membranous, skirt-like; basal bulb, 5–15 mm diam., with yellowish margin. Context white, reddish at the base. Odor & taste not distinctive.

Basidiospores 9–10 × 5–7 µm, ellipsoid, thin-walled, uniguttulate, with basal eccentric apiculus, amyloid. Basidia tetrasporic. Pileipellis hyphae 2–5 µm wide, filamentous; oleiferous hyphae present.

Ecology—Solitary in pine-oak woods during July–November; mycorrhizal; widely distributed in Chihuahua, Estado de México, Hidalgo and Morelos States of México (Pérez-Silva & Herrera 1991). Edibility unknown.

Specimen examined: **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina Ruíz, A. de la Cruz Martínez (MEXU 27822); Santa María Pápalo, 12 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27829).

Comments—*Amanita flavorubescens* is easily recognized by its striking yellow pileus with yellow warts, free white crowded lamellae with floccose edges, yellowish stipe with a superior annulus and slightly reddish persistently bulbous base.

***Amanita fulva*** Fr., Observ. Mycol. 1: 2 (1815). Fig. 3

Basidiome 90 mm high. Pileus 25–45 mm diam., oval, becoming broadly convex or flat in age; brownish grey (8D2) to dark brown (8F5); surface viscid

when moist; remarkably striate margin; Lamellae 4 mm broad, whitish (9A1), free from the stem. Stipe 95 × 5 mm, with very fine hairs, without annulus; the base enclosed by a white large volva. Context white. Odor & taste indistinct.

Basidiospores 8–10 × 9 µm, globose, apiculus basal and eccentric, hyaline, inamyloid. Basidia 23–38 × 5–7 µm, tetrasporic. Pileipellis hyphae 2–8 µm wide, thin filamentous, brown.

Ecology—Solitary in pine-oak woods during July; in México widely distributed in Durango, Estado de México, Hidalgo, Morelos, Puebla and Veracruz states (Pérez-Silva & Herrera 1991). Edible, although toxic when raw or poorly cooked (Pérez-Silva 2004).

Specimen examined: **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27830); Santa María Pápalo, 11 Jul 2014, E. Perez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27833).

Comments—*Amanita fulva* is easily recognized by its often umbonate pileus, striate margin, free whitish lamellae, the stipe lacking an annulus, large white volva, and inamyloid spores.

***Amanita onusta*** (Howe) Sacc., Syll. Fung. 9: 1 (1891). Fig. 4

Basidiome 90–180 mm high. Pileus 45–90 mm diam., convex, expanding to flat in age; white (10E2) to pale gray (1B1), covered with dark grey to brownish grey pyramidal warts, 5 mm high (but shorter toward margin), veil fragments frequent. Lamellae 10 mm broad, white to pale gray (1B1), ventricose, adnexed, floccose. Stipe 90–180 × 15–25 mm, brownish-grey, paler towards the top; annulus apical but lost in age; base a ventricose to napiform basal bulb, 25–35 mm diam.; volva floccose, fibrillose, brownish grey, remnants in circles around stipe. Context whitish. Odor & taste unpleasant.

Basidiospores 9–10 × 6–7 µm, ellipsoid, thin-walled, amyloid. Basidia 38–44 × 6–9 µm, pyriform; clamp connections present. Pileipellis thick layer interwoven, hyphae 3 µm diam.; oleiferous hyphae abundant.

Ecology—Solitary in pine-oak woods during November; mycorrhizal; previously reported in México from Estado de México and Veracruz State (Pérez-Silva & Herrera, 1991) and now for the first time in Oaxaca State. Little is known regarding its edibility, but its unpleasant odor probably deters consumption.

Specimen examined: **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina Ruíz, A. de la Cruz Martínez (MEXU 27823).

Comments—*Amanita onusta* is characterized by its white to pale grey pileus covered with dark gray to brownish grey pyramidal warts, its dirty white stipe with a paler apex, and elliptical amyloid spores.

***Amanita pantherina*** (DC.) Krombh.,
Naturgetr. Abbild. Schwämme 4: t.29 f. 10–13 (1836). Fig. 5

Basidiome 50–150 mm high. Pileus 50–70 mm diam., convex, finally flattened; brownish grey (9D3), surface slightly viscid, covered with adnate white warts. Lamellae 8 mm broad, white, free, narrowed to the stem. Stipe 80–120 × 20–50 mm, white, apical annulus, smooth; basal bulb, volva with 2–3 concentric rings. Context white. Odor & taste unpleasant.

Basidiospores 7–10 × 6–9 µm, ovoid, thin-walled, with hilar appendix. Basidia 38–55 × 10–15 µm.

Ecology—Solitary in pine-oak woods during July; reported from Chihuahua, Hidalgo, Estado de México, and Puebla states (Pérez-Silva & Herrera 1991) and from Ixtlán Mountain range in Oaxaca State by Villanueva-Jiménez et al. (2006). Although there is no data regarding intoxication from the Cuicatlán District, *Amanita pantherina* is known to produce ibotenic acid (Pérez-Silva 2004; Pérez-Silva et al. 2006, 2008), which causes nervous mycetism.

Studied material. **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27831); Santa María Pápalo, 12 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27835).

Comments—*Amanita pantherina* is easily recognized by its viscid brownish pileus decorated with white to cream patches and initially striate curved margin, free white lamellae, white stipe with a superior annulus and basal bulb, and its 2–3 concentrically ringed volva.

***Amanita rubescens*** Pers., Tent. Disp. Meth. Fung.: 67 (1797). Fig. 6

Basidiome 60–80 mm high. Pileus 40–85 mm diam., convex, becoming flat; reddish to reddish white (13A2); surface covered with adnexed warts; spotted reddish where injured. Lamellae 4 mm broad, white to pale reddish (13A2), free. Stipe 70–100 × 10-25 mm, concolorous with the pileus, white; annulus large, membranous; basal bulb, staining reddish; volva scaly, reddish grey (7B2), sometimes leaving remnants in circles. Context white, staining pinkish when injured. Odor & taste pleasant.

Basidiospores 8–9 × 5–7 µm, elliptical, thin-walled, smooth, amyloid. Basidia 44–47 × 8 µm, cylindrical, tetrasporic.

Ecology—Solitary in pine-oak woods during July, widely distributed in México from Baja California, Chihuahua, Distrito Federal, Durango, Hidalgo, Jalisco, Michoacán, Morelos, Nuevo León, Oaxaca, Puebla, Sonora, Veracruz, and Zacatecas states (Pérez-Silva & Herrera 1991). Considered edible after discarding the first cooking water, which removes the toxic protein rubescenslysine. Nonetheless, *Amanita rubescens* is not usually consumed when parasitized by *Hypomyces hyalinus*.

Studied material. **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, El Sótano, 11 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27832).

Comments—*Amanita rubescens* is easily recognized by its white to reddish pileus.

***Amanita vaginata*** (Bull.) Lam., Encycl. Méth. Bot.. 1(1): 109 (1783). Fig. 7

Basidiome 70 mm high. Pileus 30 mm diam., ovoid, becoming flat with a low umbo; brownish grey (7E2), viscid when wet, covered with membranous white universal veil patches; margin radially striate. Lamellae 5 mm broad, close, free, white to pallid (1A2). Stipe 60–70 mm long, white, with scales; base enclosed in a sac-like volva, membranous, white. Context white. Odor & taste pleasant.

Basidiospores 10–11 µm, globose, hyaline, inamyloid. Basidia 50–60 µm, tetrasporic. Pileipellis with filamentous cuticle and abundant oleiferous hyphae.

Ecology—Solitary in pine-oak woods during November; widely distributed in México from Chihuahua, Estado de México, Hidalgo, and Oaxaca states (Pérez-Silva & Herrera 1991). Considered edible.

Studied material. **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina-Ruíz, A. de la Cruz-Martínez (MEXU 27824).

Comments—*Amanita vaginata* contains hemolysins and may cause severe gastrointestinal mycetism when consumed raw. Pérez-Silva & Herrera (1991) cite several common names for this species.

***Amanita verna*** (Bull.) Lam., Encycl. Méth. Bot. 1(1): 113 (1783). Fig. 8

Basidiome 100 mm high. Pileus 70–90 mm diam., hemispheric with flattened center, becoming applanate; white (23A1) to whitish cream (24A1), occasionally with some scales. Lamellae 4–5 mm broad, white (24A1), free, edges serrate, floccose. Stipe 80–90 × 40–50 mm, cylindrical, white, pale yellow in 10% KOH; annulus superior, membranous, fragile;

basal bulb 40–50 × 30–50 mm, covered with a persistent membranous saccate volva. Context white. Odor & taste unpleasant. Edibility poisonous.

Basidiospores 9–10 × 6–8 µm, ellipsoid, thin-walled, hyaline, amyloid. Basidia 40–44 × 5–6 µm, tetrasporic, yellowish.

Ecology—Solitary in pine-oak woods during November; widely distributed in México from Durango, Estado de México, Guanajuato, Guerrero, Hidalgo, Michoacán, Morelos, Sonora, and Veracruz states (Pérez-Silva & Herrera 1991); previously reported from Ixtlán belt of Oaxaca State (Villanueva-Jiménez et al. 2006).

Studied material. **MEXICO. Oaxaca**: **Cuicatlán District**, San Pedro Jocotipac, Ciénega de Cochino, 17 Nov 2013, A.J. Medina-Ortíz, F. Medina Ruíz, A. de la Cruz Martínez (MEXU 27825); Santa María Pápalo, 12 Jul 2014, E. Pérez-Silva, A.J. Medina-Ortíz, A. García-Mendoza, F. Hernández (MEXU 27834).

Comments—*Amanita verna* is similar to *A. virosa* Bertill., which differs in its positive reaction in 5% KOH and ovoid amyloid spores. Extremely toxic, *A. verna* frequently causes fatalities and cyclopeptide mycetism due to amanitins and other toxins; commonly known as "crazy fungus" (Pérez-Silva 2004; Pérez-Silva et al. 2006, 2008). Bresinsky & Besl (1990) cite the species as mycorrhizal.

## Discussion

Five of the nine *Amanita* species reported here are toxic, causing cyclopeptide mycetism (*A. verna*), pantherina mycetism (*A. pantherina*), and possibly a type of gastrointestinal mycetism when eaten raw (*A. flavoconia*, *A. flavorubescens*, and *A. vaginata*). *Amanita caesarea* is the only wild species with excellent cooked or raw edibility, although *A. rubescens* can be safely eaten after its boiling water is discarded. The edibility/toxicity of *A. onusta* remains unknown.

All nine amanitas are reported for the first time from Tehuacán-Cuicatlán biosphere reserve, which extends their known Mexican distribution.

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